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GRADUATE WORK IN SCIENCE, PAST, PRESENT AND FUTURE[1]

By Dean F. K. RICHTMYER

CORNELL UNIVERSITY

IT is generally agreed, even by casual observers, that the world seems to be passing rapidly from one era of its history into another. We of 1936 are, of course, too close to the stirring events of this decade to be able to evaluate their true significance. That task must be left to the historian of several generations hence. We are conscious, however, of the fact that momentous changes are taking place before our very eyes, in almost every phase of human society.

Those governments of the world in which revolutions have not yet occurred are undergoing an evolution so rapid that it may almost be called "revolution." It is only a few short years ago that a great war was fought "to make the world safe for democracy." But now, to our regret, the question "Is democracy safe for the world?" is being raised by persons to some of whom at least, whatever we may think of their philosophy, we must credit sincere motives.

Sometimes in our more pessimistic moods we are inclined to wonder whether our whole economic structure is not breaking down. We see rapidly changing social relations among individuals and among groups of individuals, whether the grouping be on economic or geographical lines. Even religion, usually the most stable component of society, is experiencing transitions as fundamental as they are subtle.

What are to be the characteristics of this new era

[1] Presented upon the occasion of the celebration of the twenty-fifth anniversary of the founding of the Graduate School of the Ohio State University, Columbus, Ohio, May 22, 1936.

into which we seem to be entering so precipitously, we find it difficult to forecast. Not in recent times has the future been so beclouded. Nevertheless, the educator, with obligations almost unique among those of his professional colleagues, must try as best he may so to order our present educational system and its underlying philosophy as to give to the youth of this generation adequate training for leadership in the next. The task is not easy; but it must be faced if our schools, colleges and universities are to render the service that society has a right to expect of them. It is therefore peculiarly appropriate that the Ohio State University, in celebrating the twenty-fifth anniversary of the founding of its Graduate School, should be considering plans for the future, in addition to looking backward at a quarter of a century of rich and satisfying accomplishment.

Dean McPherson has asked me to discuss the next twenty-five years of graduate work in the sciences. In some respects, graduate work in the sciences differs from graduate work in the humanities, but there are many more points of similarity than of difference. Furthermore, graduate work, taken in its entirety, is merely a part of our whole educational system, which extends in unbroken line from kindergarten, up through high school and college to research and scholarly work by the faculty. It is impossible to discuss one segment of that system apart from the others. I am inclined to the opinion that education has suffered from too many water-tight compartments that have separated the several subjects of the curriculum from each other; have separated high school from college; and this from graduate and faculty research. We see some of these compartments breaking down. They should all disappear.

Centering our attention, however, on graduate work in the sciences in its relation to higher education, we find a suitable starting point for our discussion in the question: What is the fundamental objective of our colleges and universities? One oft-quoted statement has it that they serve "to disseminate existing knowledge and to create new knowledge." But it has always seemed to me that any educational philosophy based on this as a statement of purpose leaves much to be desired. It places far too much emphasis on knowledge as such; as if the acquisition of knowledge either by the individual or even by the race is an end in itself. It is the ability to use knowledge and to enjoy its possession for cultural and other similar purposes that gives knowledge its real value. No; the dissemination of existing knowledge and the creation of new knowledge—that is to say, teaching and research—are not ultimate objectives; they are functions, serving a deeper purpose. It is the purpose of our institutions of higher education to train men and women, using the word "train" in the broadest possible sense. It is to this thought that I wish to devote major emphasis.

Conventionally, we classify the academic activities of our colleges, universities and technical school under three heads—undergraduate work, graduate work and faculty research. This classification, however, serves the purposes of organization and administration far more than of function. For reasons so old that they have long since been forgotten, the so-called undergraduate courses occupy four years. But for the five or six per cent. of undergraduates who enter upon graduate work, the transition from the one to the other involves no real discontinuity of either method or purpose. And the relations between graduate work and faculty research are so intimate as to be almost axiomatic. Graduate work reaches its culmination in the research problem, whether for the master's degree or the doctor's degree. Real research problems can not be assigned, much less directed, out of a book. They must come, and their direction must spring, out of active programs of research carried on by the faculty. In a very real sense graduate students and faculty are collaborators in a great and challenging enterprise—"the creation of new knowledge." But the real end to be sought is the training which the graduate student receives through his intimate, almost daily, contacts with the professor. The quest for the undiscovered laws of nature, compellingly fascinating as that quest is, after all is only a by-product—albeit an important one.

Accordingly, the formula for the further improvement of graduate work in the sciences would seem to be relatively simple—at least so far as a *statement* of the formula is concerned. Maintain as a graduate faculty a capable, enthusiastic group of scholars. Give them adequate opportunities—that is, both time and facilities—for carrying on research. Surround them with a relatively small number of carefully selected, well-trained graduate students—and in very large part the future will care for itself. It might seem that little more need be said about the next twenty-five years of graduate work—in either the sciences or the humanities.

The underlying principles of this formula are indeed basic, not only in graduate work, but in undergraduate work; in the high school; even in the kindergarten. The success or failure of any of the institutions of modern society depends in very large part on personnel. As applied to education, the formula is as old as education itself, and has been stated hundreds of times and in various ways.

But this formula, like mere knowledge transmitted from teacher to student, is of no use unless it can be applied. And it is in the application of the formula

that certain guiding principles and philosophies are requisite. A knowledge of the fact that the tensile strength of steel is 60,000 pounds per square inch is imperative in bridge building. But that knowledge alone will not enable the novice to design and construct a bridge.

Let it be admitted that our institutions of higher education need the services of the best minds the country can produce. Let it be assumed that those in whose hands lie the destinies of these institutions have at their disposal funds adequate to secure such services—a utopian assumption that is as far from realization as mankind is from perfection. Let us grant that the ultimate goal of education is the training of young men and women for positions of responsibility extending all the way from Greek archeology to animal husbandry. There still must be formulated, and with the changing times even reformulated, certain basic principles to guide administrators in the selection of faculties, and faculties and administrative officers jointly in carrying on their work. And we must remember that in the last analysis an institution is judged by the caliber of its faculty.

So, granted all this, what then?

Plans for the future are best made by starting from the present, with the past as a background of experience. How has graduate work in the sciences reached its present stage of development? What are the successes and the shortcomings of our present system? What changes, in either administration, procedure or underlying philosophy, should we be prepared to make in the future?

Graduate work in the sciences is of relatively recent origin in American institutions of higher education. The American college dates from colonial, indeed rather early colonial, times. Before the Revolution there were ten or a dozen colleges, lineal descendants of Oxford and Cambridge, devoted mainly to the training of ministers for the church. One half of the graduates of Harvard in its first century of existence entered the ministry. The charter of William and Mary states it as a prime object that the Church of Virginia be provided with a seminary to train ministers of the gospel. In a very real sense, therefore, these early colleges were professional schools. Their curricula were comprised largely of Greek, Latin, some mathematics, logic, philosophy and divinity. Their presidents were usually ministers. Their resources were very small. The annual budget of Yale in the early seventeen hundreds was of the order of 300 pounds. Nevertheless, these colonial institutions performed a great service, if for no other reason than that they laid the foundations of our college and university system.

An abrupt change came with the Revolution. Not only was the work seriously interrupted, for a quarter of a century, but new obligations and new opportunities appropriate to the new country came into being. By 1800 the type of institution that characterized the first half of the nineteenth century was well crystallized. Looking back with the perspective of a century, this institution seems to have differed very little from its colonial progenitor. The curriculum, rigidly fixed for all students, still consisted of Latin, Greek, mathematics, logic, philosophy, with the addition of a very little "natural philosophy" and history. Intellectual discipline and culture were the primary objectives. Professional training declined. Some one, in the middle of the century, referred to the American college as an institution which served to give to the sons of the well-to-do something the only purpose of which was to distinguish them from their less fortunate contemporaries.

Nevertheless, the colleges grew both in number and in student enrolment. By 1850 there were 234 collegiate institutions, with 1,600 teachers, 27,000 students and an annual income from all sources of $2,000,000. Well toward half of these institutions were professional schools—theology, law, medicine.

The conservatism of these colleges was in strange contrast with the restless progressivism of the new country, and by the middle of the century we note that, among many others, two shortcomings were recognized.

First, the fixed curriculum provided no opportunity and little incentive for study beyond the conventional four years—with the result that those few students who became interested in advanced work were forced to go to European institutions. This proved later to be a blessing in disguise.

Second, there was dissatisfaction with the type of training which the fixed curriculum gave. It overemphasized disciplinary and cultural values. It did not recognize the needs of the country for education along more practical lines. Moreover, the increase in knowledge, particularly in the sciences, forced into the fixed curriculum many new subjects, with the result that the four years of study became more and more superficial.

The changes which were to be made in the last half of the nineteenth century were foreshadowed by the plan adopted by the University of Virginia at its founding in 1825. The prescribed curriculum was to be abolished, and a free elective system substituted therefor. Specialization was to be encouraged, and training for particular vocations was to be introduced. In one form or another these suggestions were tried, half-heartedly, by a few other colleges, but without success. It seems to have been true then, as now, that there is no legislative body more ultra conservative than a college or university faculty!

The evolution of the modern American university began shortly after the Civil War. In its development we recognize, among others, two influences which are particularly germane to our present discussion.

First, as noted above, many young Americans, to continue their education, went to the European universities, particularly to those of Germany, where they found a freedom and an insistence on research and productive scholarship almost unknown in America. Returning to America, many of these young men joined the faculties of our colleges and universities, and, fresh from the inspiration of their European experience, by both precept and example gradually enlarged academic view-points, broadened the curriculum and in effect introduced our present system of graduate work and research. A statistical study of the academic backgrounds of professors who are now retiring from our faculties shows that many of them took their Ph.D.'s in Europe. While they represented, collectively, all branches of learning, there was special attention paid to the sciences.

The second influence has been a very powerful one —so powerful in fact as to dominate, even to control, our whole system of education. The introduction of electric power and the telephone; the rapid increase in facilities for transportation; the opening up of the rich agricultural west; the increased utilization of our vast natural resources—all emphasized, indeed made critical, the need for men, and ultimately women, with special training not only for the professions but for positions in industry. The extent to which our colleges and universities responded is indicated by the growth which has taken place since, say, 1880. In that year, there were 600 college students per million of inhabitants, and of these, eight—a vanishingly small number—were graduate students. In 1930 there were 7,500 college students per million of inhabitants —an increase of more than twelve fold over 1880; and 380 graduate students per million of inhabitants— an increase of nearly fifty fold. The first Ph.D. given in the United States was granted by Yale in 1861. The University of Pennsylvania followed in 1870; Harvard in 1873; and Columbia in 1875. According to Walton C. John[2] 44 Ph.D.'s were granted in America in 1876. At the present time the number exceeds 2,600 per year.

Since our colleges and universities, particularly our graduate schools, have grown so rapidly in response to the needs of industry, technology and the professions, it is perhaps but natural that these needs should permeate to every nook and corner of our whole system of education. If I were to select one adjective that more completely than any other characterizes modern education, it would be the adjective "utilitarian." Graduates of high schools are supposed to have been inadequately educated unless they are prepared at once to enter some business or trade; and, wisely or unwisely, the curriculum has been shaped to that end. Students enter college, not merely in the professional courses, but in colleges of liberal arts and sciences as well, with the definite, almost sole, objective of securing a preparation for a life work. And this same objective motivates most of those who continue on into graduate work. This applies equally to the student of English, who goes into teaching or professional writing; to the student of chemistry, who goes into industrial chemistry; and to the student of geology, who goes searching for oil. Not only are many of the courses, both graduate and undergraduate, deliberately designed with this end in view, but universities have officially recognized their assumed obligations by organizing placement bureaus to secure positions for young graduates.

In short, the American university of 1935 is almost the complete opposite of the college of the first half of the nineteenth century. The latter emphasized culture and mental discipline almost to the exclusion of the so-called "practical" objectives. The former emphasize practical training with far less relative attention to culture and mental discipline. The pendulum has reached the other end of its swing.

Now, of course no one would for a moment recommend that we discard the developments of the past half century, even if those developments have been mushroom-like, and return to the college of 1850, with its narrow, fixed curriculum and its almost complete indifference to the practical needs of the current civilization. The exceedingly complex structure of modern society demands men with highly specialized training, to build our bridges and power plants; to levy our taxes and to man our courts; to organize and direct our industries; and to invent new things to be used as necessities, conveniences and luxuries for an increasingly voracious public. Only the colleges and technical schools can supply men with such training. As knowledge has increased, the extent of specialization required has increased. The length of time which a student must devote to his studies has increased. And thus the graduate school has been called on more and more to provide what in almost every subject amounts to professional training.

Nevertheless, the modern university lacks something which the earlier college, in spite of its many shortcomings, did emphasize. For example, it is debatable whether long, concentrated study in a very narrow field is the best training even for the embryo specialist. A few months ago during an all-day trip in a chair-car I chanced to get in conversation with a traveling companion, who was manager of a large real estate busi-

[2] Bulletin No. 20, 1934, U. S. Department of Interior.

ness in a mid-western city. He told me that one of his duties was each year after commencement to engage for his company a number of high-school graduates, to run errands, collect rents and ultimately to develop into more responsible positions. His criterion for probable future success was four good years of high-school Latin. This he regarded as far more important than the specialized training provided by the commercial courses in high school. "Latin," said he, "is a sieve. Only the better minds get through. Also," he continued, "Latin provides a disciplinary training, which is as real as it is difficult to analyze." This real estate dealer was looking for a mind; not for an automaton.

However, it was the emphasis on culture or more properly speaking on non-utilitarian objectives, inherent in the colleges of a century ago, to which I particularly refer. Whether the Latin and Greek and rhetoric characteristic of that period constitute the *sine qua non* of culture is not the point. One of the most uncultured men I know is a Shakespearian scholar. A mechanical engineer of my acquaintance would instantly be classed as a cultured gentleman in any group. I do not know an acceptable definition of culture; nor am I very much concerned about it. But what I am concerned about is the fact that while our colleges and graduate schools have developed to a point of high efficiency the technique of training men and women how to earn a living, they have grossly neglected the technique of training men and women how to live.

But, it may be asked, what has all this to do with the next twenty-five years of graduate work in the sciences? Graduate students, and their faculty colleagues, will continue to be concerned with finding new methods for splitting atoms; with bridging the gap between animate and inanimate matter; with elucidating the many puzzling problems of vital processes; with peering into still further depths of space by, perhaps, 400-inch telescopes. For the most part these investigators, both old and young, will be motivated by a desire to study the phenomena of nature; not by any hope of personal gain, even remote, as a result of these researches. Could anything be farther from "utilitarian"?

The answer, I think, is to be found in repeating our statement that the primary function of any university is to train men. These young graduate students, embryo scientists, are being trained for careers. Some will go into industry; some to government laboratories; some will continue in universities, where they will train the next generation of scientists. But wherever they go, they are, in their graduate work, laying the foundations of a career, just as truly as if they had been studying medicine or law or engineering, instead of physics or biology or astronomy. The fact that they enter science for the love of it is no distinguishing feature. So does the *real* professional man, if he makes a success of his profession. I have never built a bridge. But I can well understand that the bridge designer gets as much joy and satisfaction over seeing the bridge he has built, as I do when I have discovered some hitherto unknown relationship among physical phenomena. The fact that the bridge builder's monthly check may be ten times my own doesn't in the slightest alter the argument.

We should, of course, continue to strive unceasingly for better faculties, better facilities, enlarged opportunities for carrying on scientific research in our universities, and thereby the better to train young men and women for careers in science. But when we have given them our best we have succeeded, sordid though the expression may be, merely in teaching them to earn a living. I am bold enough to predict that this business of *earning* a living, essential though it is, will be somewhat less important in this new era ahead of us than it has been in the past half-century. Living outside of one's profession; taking a deeper interest in the trends of human society; trying to understand the many puzzling problems which are ever before the race; accepting one's responsibilities as a world citizen; drinking deeper of the great enrichments of life—these will play a larger part in the future than they have in the past. We will do our young scientists an ill service, if, in our enthusiastic emphasis on a scientific career we detract their attention completely from this business of living. A scientist who knows only his science is as narrow as an engineer who knows only his bridges; or as a classicist who knows only his Greek. The world can never make progress if it is made up of narrow men.

With a few notable exceptions, scientists as a group have not been very active in extra-scientific affairs. This is to be regretted. For not only has science been almost solely responsible for moulding, for better or for worse, the material aspects of present-day civilization, which in turn have influenced so profoundly our whole social complex; but science is unique in the extent to which it recognizes no international boundaries. There is a voluntary and very effective cooperation and, more important, a kind of camaraderie among scientists of all nationalities that our leaders in world affairs could do well to study. One recognizes, of course, that it is far easier to discuss objectively data on cosmic rays than the problems of the tariff or the limitation of armament. And one would not for a moment imply that scientists could solve problems, where statesmen have failed. Nevertheless, I believe that the scientists can render service in ad-

dition to discovering new phenomena to serve as bases for new gadgets and new inventions. That he has not done so is, again, due in part at least to the fact that his training has been rather narrowly specialized.

In short, of the many problems which will have to be faced in organizing and administering graduate work in science in the next twenty-five years, I believe that none is more important than that of finding ways and means of impressing upon the embryo scientist the fact that he has both obligations and opportunities outside of his professional field—a remark that is probably applicable to every branch of higher education.

How is this to be accomplished? I wish I had wisdom enough and experience enough to answer the question—or even to make constructive suggestions as to lines of approach to the solution.

I am quite sure that no formal changes in the conduct and administration of graduate work will be in the slightest degree effective. It matters not whether it takes two years or four years to get a Ph.D.; nor whether the direction of the work of a graduate student be in the hands of one faculty member or ten; nor whether the thesis occupies one fourth or three fourths of the entire period of study. I am equally sure that the addition of required, liberalizing courses would be of no avail; would be a step in the wrong direction. We should reduce, rather than increase, the *formal* requirements for a degree. What is needed is the development of an attitude of mind. Preaching, in the guise of instruction, would almost certainly produce an adverse reaction.

Nor will this problem be solved by any one man or group of men; nor in a day or a year or a decade. It has required a half-century to bring the technique of graduate instruction to its present point of effectiveness in the training of specialists. It will require another half-century to perfect methods of extending that training along the lines I have indicated. The methods to be employed must be as subtle as is the problem itself.

Perhaps, however, I might presume to make a couple of suggestions.

I return again to the question of the graduate faculty. So long as the faculty is interested only in the training of specialists, only specialists will be trained. If we would turn out young doctors of philosophy with broader interests, we must have faculties made up of men with broader interests. For it is generally agreed that the personal influence which a faculty, mainly in indirect ways, exerts upon its student body is more potent than the instruction which it gives. To build up such faculties is the task of administrators. The task will require careful selection in the filling of new positions; much time; and, above all, the backing, even demands, of public opinion. Our utilitarian colleges evolved in a utilitarian age. Colleges which emphasize both utility and culture will be found only in a society which places culture on a par with utility. This comparatively young country of ours is still a long way from that goal. To lead the public in that direction is both the opportunity and the obligation of university administrators, faculties and alumni—a task in which the alumnus who has his Ph.D. in science may, if he will, play a prominent part.

This brings me to the second suggestion—still farther from any hope of early realization. I have emphasized the desirability of the scientist's acquiring a deeper interest in, and a better understanding of, the various extra-scientific problems of the day. Conversely, I hope the time may come when the general public will have a better understanding of, and perhaps a keener interest in, research in pure science. To-day there is, I fear, much mutual misunderstanding. The scientist, engaged as he is in non-profit-making pursuits, finds it difficult to understand why the people of this country are willing to spend a couple of billion dollars per year for cigars, cigarettes and tobacco, chewing gum and the like, while the total budget of all our collegiate institutions, support for research included as a very small fraction thereof, is only a little over a quarter of that sum. He himself finds the search for new knowledge so fascinating that he is frequently hurt when the public fails to share his enthusiasm or even laughs good-naturedly at it. A large part of the public, however, with so many of its non-working hours occupied with the sports-page of the evening paper, the current movies in town and with radio-jazz providing the background for what little thinking there is, fails to see why any red-blooded man should want to spend his time with test-tubes, microscopes and galvanometers. (I perhaps err in mentioning the last-named instrument, for probably "the public" has never heard of it!) There is recognition of what is *called* science, but this recognition is mainly lip-service, and in any event is confined largely to applied science—really engineering development—which produces new radios, television, faster automobiles and airplanes, and the like. These commercial products of applied science are what the public *sees*. Behind them, the public hears much about the industrial research laboratory—frequently referred to as houses of magic, and the workers therein as magicians. We all like to see a clever magician do his tricks; pull rabbits out of empty hats. But, having no faith in the spontaneous generation of rabbits, we know that the magician somehow got the rabbit into the hat without our seeing it. It is *that* cleverness that we admire and applaud. If these exceedingly capable industrial scientists and engineers are able to pull scientific rabbits out of hats,

it is because somehow the rabbits were placed there in advance. For this the pure scientist, working behind the scenes, is in large part responsible. The public sees only the play; not the author and the backstage force.

It should not be difficult to find ways and means of educating the public to understand the contributions that pure science makes to world progress. Indeed, various agencies are already working toward this end—newspapers, periodicals, occasionally radio, for example. The public is reasonably responsive to anything which has a utilitarian end. When it becomes generally understood that to expand industry we must have applied science; to have applied science we must have pure science; then pure science will receive increased recognition, and perhaps more adequate support.

But—a utilitarian argument again! Are scientists ready to admit that the only justification for maintaining laboratories for work in pure science is that out of those laboratories may come a few discoveries that may ultimately find industrial applications? I am sure that scientists themselves do not believe so. While they are usually gratified when a scientific discovery does become "useful," as the man-of-the-street uses the term, it is not for that purpose that they carry on research. They believe that science —a knowledge of the universe around us and its laws —should interest the average citizen; that in the scheme of modern society science, pure science, should have a place at least on a par with art and music and poetry. The pictures on the wall do not make the house warmer in winter. Yet it is a poor room indeed that does not have them.

But what are scientists themselves doing to urge this view-point? And who will do it, if not the scientists?

I believe that graduate schools can very greatly extend their services during the next twenty-five years by broadening their own horizons beyond the utilitarian specialization characteristic of the past half-century. By means of that subtle thing called "atmosphere," and in various other ways they can see to it that "doctor of philosophy" means something more than a badge of professional proficiency; and that the holders thereof are men and women who recognize and accept their obligation to help make this a better world in which to live.

OBITUARY

CHARLES E. JOHNSON

IN the untimely passing of Professor Charles E. Johnson on June 6, at the age of fifty-six years, the field of zoology sustains a very real loss.

Born in Oslo, Norway, on April 24, 1880, he came to this country with his parents at the age of two, the family settling near the town of Warren, Minn., on the east side of the Red River Valley. Their arrival was about contemporaneous with the disappearance from that region of the last herd of bison, but Dr. Johnson used to relate how their whitened skulls dotted the prairie for many years afterwards.

After graduating from Warren High School, he attended the University of Minnesota, taking his A.B. in 1906, A.M. in 1907 and Ph.D. in 1912. For brief periods he worked with Dr. Minot at Harvard and with Dr. B. M. Allen at Wisconsin. During this period of university study, he made frequent long trips into the wild, among others a journey to the west coast in 1907, traveling on foot across Vancouver Island. He also took the first motion pictures of animal life in the Superior National Forest during the summers of 1912–1915, as photographer of the James Ford Bell expedition, which films are now in the Museum of the University of Minnesota. He was an expert woodsman, known as a crack shot with the rifle, and in addition a member of the university championship strong man team.

In 1914 he married Miss Jane Wood. After teaching at Minnesota from 1912 to 1918, and at Kansas from 1919 to 1923, he went to the New York State College of Forestry and in 1926 became director of the Roosevelt Wild Life Station at that school. In this capacity he supervised and edited a series of publications on the animal life of New York State which are unsurpassed in the quality and extent of the work which they represent.

Author of about forty contributions to zoology, in his earlier days he published outstanding work on the pharyngeal derivatives of the turtle, but in later years he abandoned embryological and anatomical studies for the field of vertebrate ecology. His papers on the beaver in the Adirondacks and the muskrat in New York are regarded as classics in their field. Throughout his entire life he was a passionate student of wild life, and any excursion into the country was for him an occasion for study and observation.

In photography he found his chief hobby and diversion, producing work which was often accepted for public exhibition. As teacher and scientist, his chief personal qualities were painstaking thoroughness and honesty. In a day when the field of education has become debauched by so much of fad and folly, he was almost unique in his adherence to high academic standards and sound scientific principles. He had no use for opportunism or expediency in any form, and

in his judgments he was guided by his sense of truth and fairness alone.

Modest and retiring by nature, Dr. Johnson never went out of his way to invite the friendship of the many; he cared little for the ordinary run of social amusements, and was too sincere to be the average "good mixer"—qualities which often caused him to be misunderstood by those who were only casually acquainted with him. But he nevertheless had a genuine interest in people, and under an apparently impassive exterior he harbored a keen sense of humor. Those who knew him well will recall that no one could tell a good yarn with better effect or more genuine gusto, and his close associates came to appreciate the real warmth and kindliness of his personality.

He is survived by his widow, their two children and his brother, Arthur M. Johnson, of the University of California at Los Angeles.

JUSTUS F. MUELLER
N. Y. STATE COLLEGE OF FORESTRY

RECENT DEATHS

DR. MARK FRANCIS, dean of the school of veterinary medicine at the Texas Agricultural and Mechanical College and chief of the division of veterinary science at the experiment station, died on June 28, at the age of seventy-three years.

DR. H. C. GRAHAM, president of the New Mexico State Teachers College at Silver City, N. M., died on June 21. Before his appointment as president of the college in 1933, Dr. Graham had served as head of the department of chemistry for five years, and during his presidency he continued his teaching and research in that field. He had gone to the New Mexico college from Eastern State Normal School, Madison, S. D. Dr. Graham was a graduate of Ouachita College and received his doctor's degree from the University of Iowa. He was thirty-six years old.

Nature announces the following deaths: Professor A. A. Bowman, professor of moral philosophy in the University of Glasgow, on June 12, aged fifty-three years; Sir George Hadcock, director of Vickers-Armstrongs, Ltd., and of Armstrong Whitworth, on June 4, aged seventy-five years; and Professor Charles A. King, principal of the Engineering College and Jodhpur Hardinge professor of technology in the Benares Hindu University since 1919, on May 19.

SCIENTIFIC EVENTS

EXHIBITION OF HISTORIC SCIENTIFIC APPARATUS

Nature reports that the Cambridge Philosophical Society has been responsible for the arrangement of a large and interesting exhibition of historic instruments and records which was opened by Lord Rutherford on June 8 and was on view until June 20. Acting on the suggestion and with the help of Dr. R. T. Gunther, of Oxford, an attempt was made to collect together old apparatus illustrating the work of well-known Cambridge men, as well as some of the equipment used by students of natural knowledge in former days. The collection gave an idea of the material instruments by the aid of which scientific progress has been made in the university, and it established contact with the present day by the inclusion of series showing the progress in the design of certain important pieces of apparatus like electrometers, electroscopes, galvanometers, air pumps, slide rules, microscopes and microtomes.

Among the pieces of special interest are the fourteenth century astrolabe believed to have belonged to Dr. Caius, a circular slide-rule designed by William Oughtred and made about 1640, Pepys' Musarithmica, the instruments used by W. H. Miller in making the Standard Pound, and the microscopes of Charles Darwin and of his grandfather Erasmus.

The remains of the equipment of the observatories of Trinity and St. John's Colleges and a number of Maxwell's instruments form important features, while the cabinets of materia medica preserved since the early eighteenth century in the libraries of Queen's, St. Catherine's and St. John's Colleges were shown together for the first time. The microscopes used by Francis Maitland Balfour form another exhibit interesting to biologists.

BOUNDARIES OF NATIONAL FORESTS

BY two proclamations signed by President Roosevelt, new boundaries have been given to the George Washington and the Monongahela national forests. The Monongahela is now confined to West Virginia and administration will be facilitated. The George Washington in Virginia will continue to include for the present some area in West Virginia, but the consolidation will make for improved administration.

Similar action was taken recently when portions of several units further south were combined into a new national forest entirely within Virginia. It was named the Jefferson National Forest. Sections of the Monongahela stretching across the state line into Highland, Bath and Allegheny counties, Virginia, will be detached from the Monongahela and added to the George Washington.

The George Washington National Forest recently was enlarged by consolidation of the old Shenandoah

and the Natural Bridge national forests in Virginia. The new proclamation will add a small area of the Mountain Lake National Forest purchase unit to the George Washington. This area is the northern tip of the former Mountain Lake Unit, north of U. S. Highway 60, between Clifton Forge and Lexington and readily accessible to headquarters at Harrisonburg.

At the same time, that portion of the old Natural Bridge unit south of the James River has been detached from the George Washington and added to the new Jefferson Forest. The gross area of the George Washington National Forest as proclaimed is approximately 1,756,000 acres, of which 855,000 acres are now owned, or are in process of purchase, by the United States. Not all the gross area within the boundaries of the forest will be purchased by the government, as certain areas are suitable for farming or purposes other than forestry.

The Monongahela National Forest, proclaimed in 1928, lies on the headwaters of the Monongahela, Potomac, James and Kanawha Rivers. With the boundary readjustment, it will have an area of approximately 1,674,000 acres, of which 779,000 acres have been bought or are now being acquired. Large portions of both these national forests formerly bore dense stands of commercial timber. Much of the timber has been logged off and the lands burned over. Many other portions have been farmed, and the attempts at agriculture and grazing have in many cases resulted in severe erosion. Practically all the area, however, is suited to timber growing and will be managed by the Forest Service for the production of timber crops and for watershed protection. Areas with outstanding scenic features and recreational possibilities will be developed for public use.

THE ALPHA EPSILON DELTA CONVENTION

THE Alpha Epsilon Delta National Honorary Pre-Medical Fraternity held its fourth biennial convention with the Texas Beta Chapter at Baylor University, Waco, Texas, on April 9, 10 and 11. This convention marked the celebration of the tenth anniversary of the founding of the fraternity at the University of Alabama on April 29, 1926.

One of the more important actions of the convention was the adoption as a national project of the fraternity, the promotion of a general education in preventive medicine among college students, especially to break down the taboos which prevent the practice of social and mental hygiene. The fraternity went on record to use its influence in encouraging all pre-medical students to take four years of a general cultural course leading to a bachelor's degree as the best preparation for the study of medicine. It was recommended that a closer contact be maintained with the American Medical Association, the American College of Surgeons and the Association of American Medical Colleges. The office of historian was combined with that of the secretary and designated as the central office of the fraternity.

The installation of the Oklahoma Alpha Chapter at the University of Oklahoma immediately following the convention increased the chapter roll to seventeen active chapters. Only universities and colleges that are members of the Association of American Universities, or other recognized associations, such as the Middle Atlantic Association of Colleges and Secondary Schools, etc., and are also on the approved list of colleges compiled by the council on Medical Education and Hospitals of the American Medical Association are eligible to petition for chapter membership.

The fraternity was founded as an honor society for pre-medical students and its aims are fourfold: (1) To encourage excellence in pre-medical work by furnishing a goal toward which the student may strive during the early semesters of his or her pre-medical career. (2) To bind together similarly interested students. (3) To act as a force in crystallizing any movement for the good of the pre-medical students. (4) To bridge the gap between the spirit of the pre-medical school and that of the school of medicine.

Officers elected were: *President,* Dr. Emmett B. Carmichael, School of Medicine, University of Alabama; *Vice-president,* David E. Botter, Jr., University of Texas; *Secretary-Historian,* Dr. Maurice L. Moore, department of chemistry, Yale University; *Treasurer,* W. H. McMurry, Fairfield, Ala.; *Councilor-in-the-West,* Professor Charles F. Poe, University of Colorado; *Councilor-in-the-East* (to be appointed later).

The fraternity publishes a magazine, *The Scalpel,* which contains articles of general interest to pre-medical students as well as fraternity news.

THE TERCENTENARY SESSION OF THE HARVARD SCHOOL OF PUBLIC HEALTH

FIFTEEN specialists on public health will speak at a symposium on "The Atmospheric Environment and its Effect upon Man" at a special Tercentenary Session of the Harvard School of Public Health extending from August 24 to 29. These meetings will immediately precede the two-week Tercentenary Conference of Arts and Sciences.

The public health symposium will include a series of four lectures daily on such subjects as physical fitness, fatigue, air-borne disease and the occurrence and effects of gases. The speakers will also discuss air-conditioning in modern life and the effects of abnormal temperatures and humidities upon man. Other

lectures will deal with industrial operations in compressed air, the pneumoconioses and their prevention and the design, cost and operation of laboratories of industrial toxicology and industrial hygiene.

The visiting speakers will be: Ole Singstad, chief consulting engineer on tunnels, Port of New York Authority; William P. Yant, supervising chemist of the health laboratory section and supervising engineer of the Pittsburgh Experiment Station, U. S. Bureau of Mines; J. J. Bloomfield, sanitary engineer, U. S. Public Health Service, and W. F. von Oettingen, director of the Haskell Laboratory of Industrial Toxicology, Wilmington, Del.

The following members of the faculty of the Harvard School of Public Health will lecture: Cecil K. Drinker, professor of physiology and dean of the school; David B. Dill, assistant professor of biological chemistry; Wilson G. Smillie, professor of public health administration; William F. Wells, instructor in sanitary science; Laurence T. Fairhall, assistant professor of physiology; Constantin P. Yaglou, assistant professor of industrial hygiene; Louis A. Shaw, assistant professor of physiology; W. Irving Clark, physician to the Norton Company and assistant professor of the practice of industrial medicine; Theodore F. Hatch, instructor in industrial sanitation in the Harvard Schools of Engineering and of Public Health, and Arlie V. Bock, Oliver professor of hygiene.

OFFICERS OF THE NATIONAL RESEARCH COUNCIL—1936–1937

THE National Research Council announces the appointment of Dr. Ludvig Hektoen, director of the John McCormick Institute for Infectious Diseases in Chicago, as the chairman of the council for the year beginning July 1, 1936, in place of Dr. Frank R. Lillie, resigned. Dr. Lillie continues as president of the National Academy of Sciences.

The officers of the divisions of science and technology of the council for the coming year, among whom there are several replacements, are as follows:

Physical Sciences

R. A. Millikan, *chairman;* director of the Norman Bridge Laboratory of Physics and chairman of the executive council, California Institute of Technology, Pasadena.

H. A. Barton, *vice-chairman;* director of the American Institute of Physics, New York City.

Engineering and Industrial Research

Vannevar Bush, *chairman;* vice-president and dean of the Graduate School, Massachusetts Institute of Technology.

Howard Poillon, *vice-chairman;* president of the Research Corporation, New York City.

Chemistry and Chemical Technology

Herbert R. Moody, *chairman;* professor of chemistry and director of the chemical laboratories, College of the City of New York.

Geology and Geography

Edson S. Bastin, *chairman;* professor of economic geology, University of Chicago.

Robert S. Platt, *vice-chairman;* associate professor of geography, University of Chicago.

Medical Sciences

Esmond R. Long, *chairman;* professor of pathology, School of Medicine, and director, Henry Phipps Institute, University of Pennsylvania.

Howard T. Karsner, *vice-chairman;* professor of pathology and director of the Institute of Pathology, Western Reserve University.

Biology and Agriculture

R. E. Coker, *chairman;* professor of zoology and chairman of the Division of Natural Sciences, University of North Carolina.

H. P. Barss, *vice-chairman;* principal botanist and associate in experiment station administration, Office of Experiment Stations, U. S. Department of Agriculture.

Anthropology and Psychology

W. S. Hunter, *chairman;* professor of psychology, Brown University.

J. R. Swanton, *vice-chairman;* ethnologist, Bureau of American Ethnology, Smithsonian Institution.

SCIENTIFIC NOTES AND NEWS

AT a meeting of the Royal Society held on June 25 the following were elected foreign members: Professor Siegmund Freud, the distinguished psychiatrist of Vienna; Professor Ludwig Jost, formerly of Heidelberg, "whose researches on the growth and irritability of plants have contributed much to the advancement of botany"; Professor F. A. Vening Meinesz, of Utrecht, "who devised a means of determining gravity at sea and has carried out a large amount of practical work on this subject in submarines"; Professor Hermann Weyl, of Princeton, "well known for his work in mathematics and mechanics, and especially for his discovery of non-metrical space." At the same meeting of the society, Sir Thomas Middleton, formerly professor of agriculture at the University of Cambridge, later from 1906 to 1919 assistant secretary of the British Board of Agriculture, was elected a fellow under the statute which provides for the occasional election of "persons who either have rendered conspicuous service to the cause of science or are such

that their election would be of signal benefit to the society."

THE King of England's birthday honor list includes the conferring of knighthood on Dr. G. T. Morgan, of the Department of Scientific and Industrial Research; Dr. A. C. Seward, master of Downing College and professor of botany at the University of Cambridge; Dr. James Morton, a pioneer in the dye and color industries, and Dr. C. S. Hicks, professor of human physiology at the University of Adelaide.

THE doctorate of science was conferred on June 14 by Dartmouth College on Dr. Thomas Barbour, director of the Museum of Comparative Zoology at Harvard University, and on Dr. Francis G. Blake, professor of medicine at Yale University.

AMONG the honorary degrees conferred at the commencement of Syracuse University was the doctorate of science on Dr. William L. Bray, professor of botany and dean of the Graduate School.

THE Polytechnic Institute of Brooklyn conferred on June 17 the honorary degree of engineering on Morris Evans Leeds, president of the Leeds and Northrup Company of Philadelphia. President Harry S. Rogers, who gave the citation, said: "Morris Evans Leeds, scientist, inventor and preeminent industrial leader, builder of precision instruments for scientific measurements and control, in the industry which you lead you have united the highest craftsmanship with the deepest scientific theories; around both you have organized human effort inspired by the loftiest social ideals. Public servant in industry, in education and in labor relationships, you have won the affection and high regard of craftsmen, scientists, engineers, managers and the public."

THE Award of Merit for 1936 of the University of Louisville has been bestowed upon Dr. John Walker Moore, dean of the School of Medicine, for "Significant contribution through research upon cardio-vascular functions; establishment a decade ago of the student unit system of clinical instruction, original features of which have been incorporated into the curricula of other medical schools; effective and stimulating teaching; distinction conferred by election to chairmanship of the section on medical education of the Southern Medical Association, 1932–1934; distinction conferred by election to membership among the two hundred physicians nationally outstanding in research and practice, who constitute the Association of American Physicians."

AS a mark of affection and esteem for Professor Gomberg, who recently retired at the age of seventy years, a group of his friends and former students have presented his portrait to the University of Michigan. The portrait was painted by Isabel Branson Cartwright, of Philadelphia, and is temporarily hung in Alumni Memorial Hall.

DR. ALICE HAMILTON, who recently retired from an assistant professorship of industrial medicine at the Harvard Medical School, was presented on June 22 at White Sulphur Springs, W. Va., with the gold medal of the Chi Omega Sorority. The medal, which is given annually to an American woman for public achievement, was presented by Mrs. Roosevelt, who represents the field of public affairs on the committee of awards.

DR. ROGER JOHN WILLIAMS, professor of chemistry at Oregon State College, has been presented with the scroll given annually by the University of Oregon Chapter of Sigma Xi to an "outstanding man of science in Oregon," for his work on "pantothenic acid." The Rockefeller Foundation has appropriated $20,000 for further research in this field.

A. M. MACCUTCHEON, engineering vice-president of the Reliance Electric and Engineering Company, Cleveland, Ohio, was elected at the Pasadena meeting president of the American Institute of Electrical Engineers for the year beginning August 1. Other officers elected were: *Vice-presidents,* A. C. Stevens, Schenectady, N. Y.; O. B. Blackwell, New York, N. Y.; C. Francis Harding, Lafayette, Ind.; L. T. Blaisdell, Dallas, Texas; C. E. Rogers, Seattle, Wash.; *Directors,* K. B. McEachron, Pittsfield, Mass.; C. A. Powel, East Pittsburgh, Pa.; R. W. Sorensen, Pasadena, Calif.

FRANCIS C. FLINT, Zanesville, Ohio, chief chemist of the Hazel-Atlas Glass Company, has been elected president of the American Ceramic Society.

AT the thirty-first semi-annual meeting of the Central New York State Branch of the Society of American Bacteriologists at Rochester, N. Y., Dr. C. N. Stark, Cornell University, was elected *chairman* for 1936–37; Dr. C. S. Pederson, New York State Agricultural Experiment Station, *vice-chairman,* and Dr. Ralph P. Tittsler, University of Rochester, *secretary-treasurer.*

MAJOR JAMES STEVENS SIMMONS, of the Army Medical Research Board, Ancon, C. Z., was elected president at the meeting on June 16 of the Medical Association of the Isthmian Canal Zone.

PROFESSOR DONALD H. ANDREWS has been appointed chairman of the department of chemistry and director of the Chemical Laboratory at the Johns Hopkins University.

DR. MORLEY A. JULL, senior poultry husbandman of the U. S. Department of Agriculture, has been

appointed head of the poultry department of the University of Maryland.

R. J. GARBER has resigned as head of the department of agronomy and genetics of West Virginia University to become a principal agronomist in the Division of Forage Crops and Diseases of the Bureau of Plant Industry, U. S. Department of Agriculture. He will be director of the Regional Laboratory for Pasture Research in the northeastern states. Headquarters have been established at the Pennsylvania State College of Agriculture.

DR. HENRY STEVENS, biochemist of the Protein and Nutrition Division of the Bureau of Chemistry and Soils, has been placed in charge of a chemical study of substances in agricultural products and by-products that contribute to the allergic disturbances—hay fever, asthma, hives and related afflictions. Dr. Harry S. Bernton, professor of hygiene at the Georgetown University Medical School, has been appointed consulting specialist and will participate in studies of the allergens. Funds for this investigation have been provided by the Bankhead-Jones act, signed by the President a year ago.

DRS. ARTHUR B. CLEAVES, Donald Fraser and E. H. Watson have been appointed cooperative geologists of the Pennsylvania Topographic and Geologic Survey for the summer of 1936.

DR. CLARENCE J. WEST, since 1925 director of the Research Information Service of the National Research Council, has accepted appointment to the newly established position of technical editor of the Institute of Paper Chemistry, which is affiliated with Lawrence College at Appleton, Wis. He will be in charge of all publications, bibliographies and preliminary researches at the institute.

AT Kansas State College sabbatical leave for 1936–37 has been granted to the following members of the scientific staff: Roger C. Smith, entomology; A. O. Flinner, mechanical engineering; Gerald Pickett, applied mechanics; C. E. Pearce, machine design; H. E. Myers, agronomy; H. M. Scott, poultry husbandry; Gladys E. Vail, food economics and nutrition; A. C. Andrews, chemistry, and E. R. Lyon, physics.

THE award by the Fox Trust Fund of three research fellowships for the year beginning June 1 has been announced by the New Hampshire State Forestry and Recreation Department. Dr. Richard G. Wood, of Manchester; Alan A. Beetle, of Hanover, and Livingston Lansing, of Salisbury, Conn., were elected fellows. The fellowships are awarded each year for research in forestry and subjects allied with forestry in New Hampshire. The fund was established by the late Caroline A. Fox and is administered under the Fox Research Forest in Hillsboro.

DR. WENDELL H. GRIFFITH, associate professor of biochemistry at the St. Louis University School of Medicine, has received a grant from the Rockefeller Foundation to enable him to continue at the University of Oxford his work in the field of nutrition.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Gordon H. Scott, of the department of anatomy of Washington University School of Medicine, St. Louis, to aid his work on lead and aluminum in the cerebrospinal fluid. Professor Jean Broadhurst, of Teachers College, Columbia University, has received a grant for further investigations concerning the presence and significance of cytoplasmic inclusion bodies in the epithelial cells of the genital area.

DEAN HARRIETT M. ALLYN, professor of anthropology at Mount Holyoke College, has been appointed by the Department of State to represent the Government at the second International Congress of Prehistoric and Protohistoric Sciences, to be held at Oslo from August 3 to 9. After the congress, she will visit prehistoric sites in Norway and Sweden, and during September and October will take part in an excavation at Staré Hradisko, Czechoslovakia, returning to Mount Holyoke in January.

THE third Denver-Wyoming Expedition, directed by Dr. E. B. Renaud, of the University of Denver, left on June 15 to continue the archeological survey of the High Western Plains. The expedition will explore the basin of the Green River, Black's Fork and tributaries. Dr. Renaud expects to make a collection of paleolithic implements.

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, addressed the sixty-fourth meeting of the Manufacturing Chemists' Association recently at Absecon, N. J. He spoke on "Dangers of Regimentation and Complacency."

DR. KIRTLEY F. MATHER, professor of geology at Harvard University, addressed the graduates at the one hundred and fifteenth commencement exercises of Colby College.

DR. PAUL F. RUSSELL, of the field staff of the International Health Division of the Rockefeller Foundation, recently gave a series of lectures on the epidemiology of malaria at the third International Malaria Course of the Health Section, League of Nations, in Singapore. On completion of the course Dr. Russell returned to the King Institute of Preventive Medicine, Guindy, Madras, India, where he is officer-in-charge of malaria investigations.

DR. I. M. KOLTHOFF, head of the division of analytical chemistry in the University of Minnesota, delivered a series of lectures on chemistry at the Uni-

versity of Prague, Czechoslovakia, in June, after which he left for Holland, where he will represent the University of Minnesota at the tercentenary exercises of the University of Utrecht.

PROFESSOR F. S. KIPPING delivered the Bakerian lecture before the Royal Society at Burlington House on June 25. He spoke on "Organic Derivatives of Silicon."

THE Academy of Medicine of Washington, D. C., whose organization was recently announced in this JOURNAL, has adopted the following plan for its programs. For each subject a committee of both laboratory and clinical men is appointed. The committee consists of those members who are qualified by special experience with the subject in one or another of its aspects, with, in addition, one or more members representing the academy at large. The committee in preliminary meetings studies and organizes the subject, and at a subsequent scientific meeting presents it to the academy. The reports of committee members and the discussion by the academy are informal. The first committee on subjects for study is one on "High Energy Particles and Radiations." It consists of Drs. Merle A. Tuve, Carnegie Institution, Department of Terrestrial Magnetism; Lyman J. Briggs and Lauriston S. Taylor, Bureau of Standards; George W. McCoy, National Institute of Health; Edwin A. Merritt, clinical radiology, and William J. Mallory, George Washington University School of Medicine. The first report of this committee was heard and discussed as the scientific program of the academy meeting of June 9, 1936.

Nature states that a Czechoslovak Microchemical Society was founded on April 25 in Prague at a gathering of about two hundred chemists, from both Czech and German scientific and industrial circles. Professor J. Heyrovský, professor of physical chemistry at the Charles University, known for his microchemical polarographic studies, has been elected president. The society's activities were inaugurated by a lecture by Dr. C. J. van Nieuwenburg, professor of analytical chemistry in the Delft Technical High School, on "Why and Where Microchemistry?" Austrian microchemists were represented by Professor Fritz Feigl, professor of chemistry in the University of Vienna. The society intends to cooperate with microchemical societies and clubs of England, America, Holland and Austria with the view of establishing an International Microchemical Society.

THE summer meeting of the Pennsylvania Academy of Science is scheduled to be held at Somerset on August 14 and 15. Biological and geological field trips are planned. Further particulars can be obtained from the secretary, Dr. V. Earl Light, Lebanon Valley College, Annville, Pa.

THE Biological Photographic Association will hold its sixth annual convention in Boston on September 24, 25 and 26, at the Hotel Lenox.

DISCUSSION

THE EFFECT OF IRRIGATION UPON SOIL TEXTURE

THE effect of irrigation upon soil texture has been noted in the Salt River Valley, Arizona. A soil survey was made of certain areas in 1899 and another covering much larger areas in 1927. The two surveys, where they cover the same territory, have little resemblance to each other. The first survey, made by the writer, was one of the first soil surveys made by the Bureau of Soils and would to-day be regarded as a crude reconnaissance. It did not go into detail but roughly classified the soils into sands, sandy loams, etc., to clays. The most recent survey goes into great detail and maps soils which can not be differentiated in the field by the non-scientific man. There were, however, great differences in the two surveys which can not be explained by anything but changes in the character of soils. For example, in the area around Tempe, covered by both surveys, 21 per cent. of the soils were classed as clay loams and clays in 1899, while in 1927 the maps show 82 per cent. of the same soil grades.

Such great differences can not be explained by improved methods of surveying or classifying soils. Deposition of sediment from irrigation with muddy water does not explain the differences, because no such great amount of sediment has been available in the water.

The difference between the irrigated and desert soils is more strikingly shown in the recent soil surveys where the area extends beyond the limits of irrigation. In the Buckeye region, shown on the Buckeye-Beardsley Area map, the Buckeye canal for long distances follows across unbroken desert the boundary between sandy loams and heavier soils—clay loams or silty clays. In 1899 no such difference existed; there was little difference between the soils above and below the canal.

The Paradise Verde Area map extends down to the Arizona canal, the uppermost irrigating the Salt River project. Above the canal light soils predominate. On the Salt River Valley Area sheet, which extends up to the same Arizona canal, heavy soils predominate below the canal. No such differences existed in 1899, and

no topographic or other reason exists for this change in soil type along the canal line.

From all the information available to the writer these differences are due to irrigation, which has gone on for fifty years or more. Most of the soils affected are very recent and are made up of mineral fragments washed from granitic mountains by torrential rains coming at rare intervals and spread by the floods originating in the desert storms. All the desert soils show much felspathic material, which appears to be comparatively fresh. Apparently the breaking down of these arkosic sands has caused the change in soils which has produced clay loams and clays out of sandy loams.

In the river bottom areas, where the soils are the result of sediments carried by the streams and where moisture has been present much longer than in the true desert soils, the effect is not noticeable. It is in the broad valley areas which slope from the mountains that the soil changes are most evident.

The quality of the water used in irrigation in the Salt River is a factor which should be considered. River water used by the canals in the Salt River project varies from 300 to 500 parts per million total salinity in floods to 1,500 or more parts per million at low flow. In recent years well water, higher in salinity than river water and running as high as 3,000 or more parts per million, has been mixed with the river water or used directly on many areas. In the Buckeye region, dependent in low flow periods on return water, the irrigation supply frequently runs as high as 3,000 parts per million total salinity. It may be that the use of water of this high salinity has had an effect in hastening the soil disintegration.

Two results of this change in the soils are apparent. First, the increase in clay content has made penetration of irrigation water very slow and in many cases it is difficult to get the soil to absorb enough water. This in turn tends to cause an accumulation of salinity in the soil, for where such highly saline waters are used it is necessary to use an excess above consumptive use requirements to leach out accumulating salinity.

The second effect of soil disintegration is the liberation of soluble matter within the soil. This may eventually accumulate in sufficient quantity to damage certain soils.

This short note is written to call attention to the phenomena observed in the hope that some one may be able to investigate the interesting matter.

THOS. H. MEANS

SAN FRANCISCO, CALIF.

UNPUBLISHED POEM BY T. A. CONRAD

IN connection with a discussion of the recent biography by Wheeler[1] of the paleontologist, T. A. Conrad, attention was called to the included unpublished poem[2] by Conrad.

At the time the poem was written, Conrad was paleontologist of the New York State Geological Society. Very probably the reason for his sojourn at Schoharie was because of the residence there of the John Gebhards, father and son, whose excellent collections and work on the Paleozoic section exposed at Schoharie were outstanding.

To a Trilobite

Thou large-eyed mummy of the ancient rocks,
The Niobe of ocean, couldst thou tell
Of thine own times, and of the earthquake shocks
Which tore the ocean-bed where thou didst dwell;
What dream of wild Romance would then compare
With the strange truths thy history might unfold?
How would Geologist confounded, stare
To find their glittering theories were not gold?
Methinks I see thee gazing from the stone
With those great eyes, and smiling as in scorn
Of notions and of systems which have grown
From relics of the times when thou wert born.
Thou ne'er saw glittering fishes in the deep,
Which now in multiform profusion play,
Nor giant shells, nor monsters such as sweep
Along the surge and dash the ocean spray.
Yes, small in size were most created things
And shells and corallines the chief of these;
No land but islets then, nor trees nor springs,
And no tornado thundered o'er the seas.
But the wild earthquake did the work of death,
And heaped the sand and tore the Naiad's cave.
Race after race resigned their fleeting breath—
The rocks alone their curious annals save.
And since the trilobites have passed away
The continent has been formed, the mountains grown,
In ocean's deepened caves new beings play,
And man now sits on Neptune's ancient throne.
The race of man shall perish, but the eyes
Of Trilobites eternal be in stone,
And seem to stare about with wild surprise
At changes greater than they yet have known.

T. A. CONRAD,
Paleontologist

Schoharie, June, 1840.

Although the writing of poems was a well-known phase of Conrad's life, copies of his poems are rare.

KATHERINE V. W. PALMER

PALEONTOLOGICAL RESEARCH INSTITUTION
ITHACA, N. Y.

PATHS OF FLIGHT

THE writer has noticed, from the various experiences he has had in dealing with the locusts (*Locusta*

[1] H. E. Wheeler, *Bull. Amer. Paleontology*, 23: 77, 1935.

[2] Written to Mrs. Amelia Caroline Harper Van Patten, June, 1840, at Schoharie, N. Y. The poem is now in possession of John Paul Young, of Ithaca, N. Y., a grandson of Mrs. Van Patten. Thanks are due to Mr. Young for permission to publish the poem.

migratoria migratorioides phase *gregaria* Rch. and Frm.) in the campaigns, from May 9, 1932, to July 7, 1933, and the present, that the swarms and individuals have a definite course on motion.

As a general rule the path of flight of the whole swarm is in a counter-clockwise direction. In other words, if the swarm is heading north at one place a little distance farther north the swarm will have deflected and will be heading in a northwesterly course; and if the swarm has been noticed heading on southerly course it may be expected that the swarm will be heading on a southeasterly course a little distance farther south. This counter-clockwise course is maintained at normal atmospheric conditions and as long as no temporary impediment is encountered on its flight. With head or tail winds the insects seem to be blown off their course in all directions. Also where natural barriers occur, like mountain ranges that are quite high, the chances are that the swarms will have to deflect and find a path of least resistance until it shall have again gained an open course.

The writer also has noticed that the individual of a swarm flies in a general counter-clockwise circular course. That is, each individual, within the swarm on the wing, flies counter-clockwise and the whole swarm takes a counter-clockwise course.

Because of these facts the writer has been able to prognosticate locust movements to a fair degree.

These are observations that the writer has noted of this winged pest in the Philippines. It would be interesting to know if persons who have had anything to do with locusts have ever noticed or noted the paths of flight of this insect singly and in swarm.

The writer suspects that in the northern hemisphere the paths of flight of locust swarms and individuals within the swarm are counter-clockwise, while those of the southern hemisphere are clock-wise.

ALEXANDER GORDON

LA CARLOTA SUGAR CENTRAL
OCCIDENTAL NEGROS, P. I.

UPPER DEVONIAN SPONGES

THE Carnegie Museum has recently acquired a very large series of Upper Devonian sponges of the family Dictyospongidae. The collection, which contains over 5,000 specimens, including 85 types, was made in New York and in Pennsylvania by the late Edwin Bradford Hall, of Wellsville, N. Y. The types were described by Professor James Hall and Dr. John M. Clarke in Memoir II (1898) of the New York State Museum. However, a large part of the collection had never been cleaned or prepared for identification and this work was carried on during the past year. Due to the excellence of some of the cleaned material, it may prove advisable to revise several genera and species that have not been clearly understood. These sponges will no doubt prove to be good index fossils in determining the stratigraphy of the Upper Devonian in New York and in Pennsylvania.

The writer would very much like to hear of any other collections of Upper Devonian sponges of this family, especially of any collected since 1900, or of any new localities for them which have been discovered by contemporary collectors.

E. R. ELLER

CARNEGIE MUSEUM,
PITTSBURGH, PA.

A CORRECTION

IN my review of Professor Pearse's book, "The Migrations of Animals from Sea to Land,"[1] I questioned the statement that "most species of salmon die after spawning." Such doubt, however, appears to be unjustified, for the adults of the five Pacific species of *Oncorhynchus* do not return to the ocean after their upstream reproductive migration. Only to the Atlantic salmon (*Salmo salar*), the two land-locked forms (*sebago* and *ouananiche*) and the steelhead salmon (*gairdnerii*) of the Columbia River, etc., would the objection apply.

ROBERT CUSHMAN MURPHY

SCIENTIFIC BOOKS

CRANIAL MUSCLES OF VERTEBRATES

The Cranial Muscles of Vertebrates. By F. H. EDGEWORTH. Cambridge: at the University Press. New York: The Macmillan Company. 1935. $30.00.

THERE is doubtless much to be said for the short article favored by editors of current journals, the short article which deals with some illustration of scientific thought torn from its context, or, more deplorably still, penned by an author whose thought has no context. But the day of the monograph will certainly return when donors of funds for research learn that no research is complete without adequate presentation. "Good form," wrote Gracian, "supplies everything, . . . sweetening the truth, . . . and a little manner is the thief of the heart."

This monograph by a veteran in comparative myology is gracious in form and sufficiently spacious in presentation to convey that feeling of confidence in the reader, lacking which no author can hope to make his contribution truly effective. Without prodigality

[1] SCIENCE, June 5, 1936, pp. 553–554.

of words Professor Edgeworth lays before us the investigations of a lifetime of study and experience, clearly, simply and modestly. "The theories here advanced," he writes, "may not be generally acceptable, but they are founded on evidence which has not hitherto been utilized in attempting to solve these difficult problems."

The mind of the master is evident in a writer who can see beyond his own technique. The necessity of neurological investigations, especially by experiment, is stressed at once in the preface. The new attack on comparative myology by investigation of muscle action currents naturally enough finds no place in this volume, but its significant contribution is foreshadowed.

The nineteenth century was the heyday of comparative morphology, as study of the literature cited demonstrates. The twentieth century brought experimental method to bear on the theme and pure morphological studies have dwindled in number, but the author has kept adding, even in proof, references of significance.

Another important feature in the volume is the table of synonyms, for the nomenclature of structures "has been difficult though there is an abundance of names from which to choose."

The text is the more readable because it is not peppered with reference marks. This may be a drawback to those who desire, above all things, speed in identification of source. But the volume is written for the student who knows his literary material, not as a labor-saver for the beginner in his task of mastering literature.

There is a spaciousness of presentation which strides over points of detail, again assuming that the reader knows the field. For example, on page 151, absence of the spinal accessory nerve in a giraffe seems to be attributed to Lesbre and myself, whereas Lesbre never mentioned this form and I merely quoted Elliot Smith. The attack by Zuckerman and Kiss was indeed leveled at me, but, had they recalled the literature, they would have known they were assaulting their own chief. It is unfortunate for the discussion of the cucullaris that Professor Edgeworth did not add (even in proof) the significant paper by Howell and Straus which clears up all discrepancies. A related problem of laryngeal innervation in camel and llama finds isolated expression thirty pages later on.

One of the most stimulating and original sections of the book is that on the larynx. No student of laryngeal anatomy should fail to master this section which, by its breadth of treatment and its practical application, is a choice example of scientific presentation.

Other reviewers doubtless, in browsing through the pages of so compact and enthralling a dissertation, will light on other treasures. None will find fault with the proofreading. Punctuation also is perfect. The hiccoughing comma does not affront one's propriety and full-stoppery is sparingly used. Nevertheless the implications of each sentence are clear, for he who is familiar with other languages can best handle his own.

The illustrations, so simple and effective in their line, so apt in their reinforcement of the text, should be singled out for special praise save that the singling out does violence to the symmetry of the whole.

This monograph is the record of an inspiration which has glowed through all the years of a busy life and quickens to a flame at last. "Now do's my Project gather to a head; my charmes cracke not; my Spirits obey and Time goes upright with his carriage."

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STATISTICS AND NUMERICAL TABLES

Elements of Statistics with Applications to Economic Data. By HAROLD T. DAVIS and N. F. G. NELSON. The Principia Press, Inc., Bloomington, Indiana. 424 pp. Price, $4.00. 1935.

THIS book is copyrighted by the Cowles Commission for Research in Economics, of which the authors are respectively mathematician and economist. The purpose of the work may be inferred from the recommendation in 1932 of a committee of the Social Science Research Council to the effect that students of social science should be prepared for the study of statistics by a six to nine semester hour course in the mathematical essentials involved. The topics treated are largely those traditional in the statistics of economics, but there is a wealth of fresh economic data, a good choice of new "problems" (with solutions in the back of the book) and abundant enlightening notes of a critical, historical, biographical or bibliographical nature. Despite a first heavy impression created by its large format, thick paper, sober binding, extensive appendices, numerous footnotes and formula-strewn pages, the mathematical difficulties are reduced to a minimum and the work remains within the grasp of any serious and inquiring college student, while offering at the same time many fresh ideas to the veteran teacher.

Tables of the Higher Mathematical Functions. Computed and compiled under the direction of HAROLD T. DAVIS. The Principia Press, Bloomington, Indiana. Vol. I, 1933, 377 pages. Vol. II, 1935, 391 pages.

THIS work, of which the third volume is soon to appear, is obviously the most ambitious project at preparing numerical tables of special mathematical functions attempted in this country. To those interested in such tables this monumental enterprise needs no

announcement at this time. In Volume I there are five "parts" of interest to the general reader prior to the main tables themselves. Part One concerns the classification and history of tables. Part Two deals with mathematical series used in computation. Part Three treats of interpolation. Part Four gives auxiliary interpolation tables. Part Five devotes 28 pages to general bibliography concerning tables. The separate tables constituting the main substance of this work are prefaced in each case by a discussion of the mathematical setting, with history, bibliography, etc., and a graph of the real values assumed. The number of decimal places given are usually from 10 to 20 with differences recorded, the number of places depending upon the part of the range considered. In Volume I are the log gamma function and Psi function. Volume II opens with further polygamma functions (derivatives of the Psi function). This volume continues with the Bernoulli polynomials and numbers, Euler polynomials and numbers, Gram polynomials and functions of polynomial approximation. Fundamental tables computed in this extensive fashion should serve as definitive for many generations. With the growth of statistical laboratories these tables should fill a special need. They represent the first substantial evidence in this country of a creative interest along lines in which recent British enterprise has been so conspicuously fruitful.

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REPORTS

A CENTURY OF GEOLOGIC SURVEYS IN PENNSYLVANIA

ON June 12 and 13, there was celebrated at Harrisburg the centennial of the founding of the First Pennsylvania Geological Survey. A total number of 285 persons registered for the meetings, and many others besides attended the commemorative exercises.

The first survey was created by act of the legislature dated March 29, 1836. Henry D. Rogers, the first state geologist, served until the expiration of this survey in 1858. The second survey came into being under Joseph P. Lesley, second state geologist, in 1874 and continued for about twenty years. In 1899 the third ("Commission") survey was created. Richard R. Hice served as state geologist during part of its existence, which terminated in 1919. The present or fourth survey traces its start to a new legislative act passed in 1919. This was marked by the appointment of George H. Ashley, state geologist. During the intermittent existence of the four surveys a total publication of nearly 200 reports, amounting to over 40,000 pages of text and some 50 maps and atlases, have appeared, including a number of works published jointly with the United States Geological Survey under a cooperative agreement.

The program of the celebration running through two days offered a variety of interesting events not merely to the technical guests and visitors but to the layman as well. During Friday morning the visitors registered at the offices of the Pennsylvania Topographic and Geologic Survey. Here exhibits had been arranged. Important among these were a file of publications of all four surveys, a comparison of various state maps, illustrative material of progress in topographic and geologic mapping, maps of the development of petroleum and natural gas fields, rocks and minerals, recently discovered fossils new to science or to Pennsylvania, stratigraphic charts and miscellaneous material mostly of historical interest in that it touched upon early geologic work in the commonwealth. Among the last were manuscript maps and sketches by the first survey, which were exhibited by the archives and history branch of the State Library in the Education Building. Walking tours of the capitol buildings were conducted at intervals during the morning. At noon a complimentary luncheon to the visiting delegates and invited guests was served at the survey offices.

The afternoon of Friday was devoted to a formal program in the forum of the Education Building. Addresses of welcome by Governor George H. Earle (a letter of welcome was read in the governor's absence), Secretary of the Department of Internal Affairs Thomas A. Logue and State Geologist George H. Ashley opened the program. Responses were given by M. M. Leighton, chief of the Illinois Geological Survey; W. C. Mendenhall, director of the United States Geological Survey, and Frederick Watson, His Britannic Majesty's consul general. After the responses, papers were read as follows: F. Lynwood Garrison, "Philadelphia, the Cradle of American Science"; R. W. Stone, "The Survey, 1836–1936"; George H. Ashley, "The Romance of Geology and the Part Played by Pennsylvania." On Friday evening a symposium, "The Mineral Industry and the Geologic Survey," was conducted with Samuel Taylor as chairman. The leaders were: George B. Hadesty, representing the Anthracite Industry; Carl E. Lesher, the Bituminous Coal Industry; Norman E. Maxwell, Petroleum and Natural Gas, and Paul B. Reinhold, non-metallic products.

Saturday, June 13, was devoted largely to field trips

conducted for the benefit of the visiting geologists. Three all-day trips, run simultaneously, offered a choice among a wide range of geologic phenomena because of the fact that Harrisburg is exceptionally well located for such observations. Trip A covered the area north and west of Harrisburg and included the Paleozoic stratigraphy from the Ordovician to the Pennsylvanian, Appalachian structures and physiography. It was conducted by Bradford Willard and Frank M. Swartz. Trip B visited the area southwest of Harrisburg to observe the stratigraphy of the Cambrian and Ordovician, the Triassic sediments and volcanics and the pre-Cambrian crystalline complex. This party was in charge of W. O. Hickok, IV, and R. W. Stone. Trip C was in charge of F. T. Moyer, C. W. Cumings and G. L. Adair. This trip toured the region east of Harrisburg covering the Ordovician and Triassic sediments and igneous rocks, the Cornwall iron mines and associated phenomena.

While the field trips were in progress, special entertainment was arranged for the visiting ladies. In the morning those interested met at the Rose Gardens of Dr. J. Horace McFarland. The visit to the gardens was followed by luncheon at the residence of Dr. and Mrs. Bradford Willard. In the afternoon entertainment was provided at the residence of Mr. and Mrs. R. W. Stone. At five o'clock, after the conclusion of the field trips, delegates, invited guests, the ladies and others assembled for a tea at the residence of Dr. and Mrs. George H. Ashley, which event brought the celebration to a close.

BRADFORD WILLARD

SPECIAL ARTICLES

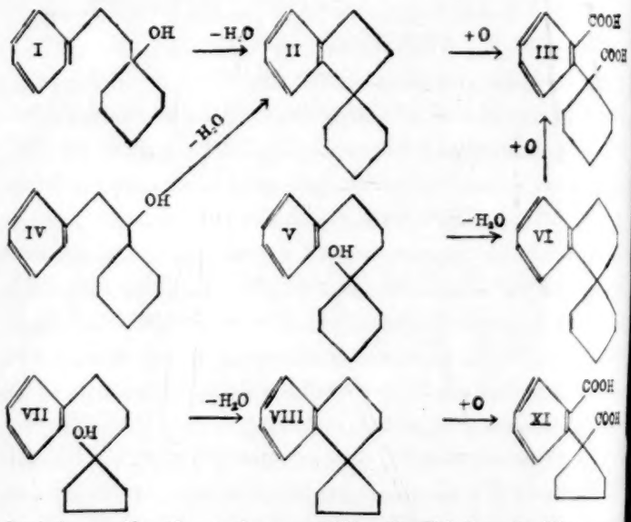
A SPIRANE BY-PRODUCT IN THE PHENANTHRENE SYNTHESIS

SINCE our preliminary communication[1] announcing the preparation of phenanthrene by the dehydration of l-phenylethylcyclohexanol-l(I), with subsequent dehydrogenation of the as-octahydrophenanthrene so produced, we have been studying this synthesis, especially from the standpoint of its mechanism and the constitution of the products. The results were submitted last month (May) to the faculty of pure science of Columbia University, in Dr. Perlman's dissertation for the Ph.D. degree. Articles based upon these experiments are now in course of preparation and will be submitted soon for publication in one of our chemical journals.

In the June, 1936, number of the *Journal of the American Chemical Society*, p. 1062, there appears a communciation by van de Kamp and Mosettig showing that they too are investigating this same problem, and it seems desirable therefore that we should announce immediately those of our results which concern the work reported by them.

By repeated distillation, they succeeded in separating the crude as-octahydrophenanthrene into two main fractions; A(20 per cent.), boiling at 135.5–135.7° at 10.5–10.8 mm; and B(70 per cent.), boiling at 142.6–142.8° at 9.2 mm; which they believe to be the two stereoisomeric forms of the octahydrophenanthrene, A having probably the *trans*- and B the *cis*-configuration. Using the Friedel-Crafts reaction, they found that A and B gave different monacetyl derivatives.

Our own experimental results have led us to a quite different conclusion, namely, that the (lower-boiling) by-product is not a phenanthrene derivative at all,



but is really the spirane (II), the higher-boiling constituent being the octahydrophenanthrene.

In support of this deduction concerning the constitution of the by-product, we offer the following experimental observations:

(1) On permanganate oxidation, it yielded the *alpha, alpha*-pentamethylenehomophthalic acid (III), whereas under similar conditions the octahydrophenanthrene gave only phthalic acid.

(2) The same spirane (II) was obtained as the by-product when benzyl cyclohexylcarbinol (IV) was used instead of the l-phenylethylcyclohexanol-l.

(3) The spirane VI, from l-phenylpropylcyclohexanol-l(V), on oxidation also gave the *alpha, alpha*-pentamethylenehomophthalic acid, one carbon being eliminated in the reaction.

(4) Similarly, the spirane VIII, prepared from l-phenylpropylcyclopentanol-l(VII), yielded on oxidation the corresponding *alpha, alpha*-tetramethylenehomophthalic acid(IX).

(5) Certain of these spiranes were fused with sel-

[1] Bogert, SCIENCE, n. s., 77: 1994, 289, March 17, 1933.

nium at temperatures up to 350°, but no phenanthrenes could be isolated from the fluorescent oily products.

Further, the formation of these spiranes was suspected by us, and their presence in the reaction products predicted, because of our experience with the indanes and ionenes.[2]

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THE OESTROGENIC ACTIVITY OF CERTAIN PHENANTHRENE AND HYDROPHENANTHRENE DERIVATIVES

A SOMEWHAT novel technique of bio-assay has been developed in the course of an investigation of the series of phenanthrene and hydrophenanthrene derivatives listed in Table I. The synthetic substances were prepared by Fieser and his collaborators, as indicated in the preceding note,* and their values for the melting points are included in the table.[1,2,3,4]

The oestrogenic activity of the compounds was tested by the intraperitoneal injection of sesame oil solutions into spayed mice at two weeks after ovariectomy. Intraperitoneal injections were employed in order to insure absorption of the oily solutions, since it has been shown[5] that such solutions are retained subcutaneously for long periods. Furthermore, we have observed definite inflammatory reactions against subcutaneous injections of certain of these and related compounds of such a nature that the oily material is eventually walled off by connective tissue overgrowth. There are in addition obvious lymphatic reactions against the subcutaneously injected material.

Various methods of assay were tested, and a standard procedure was evolved, as follows: two intraperitoneal injections of 0.2 cc each were made at twelve-hour intervals and the first vaginal smear was taken at the time of the second injection; at approximately twelve-hour intervals thereafter vaginal smears were taken until a total of nine readings was had on each animal. The animals were taken in groups of five so that a total of forty-five smears were recorded in a routine test. Prooestrus and oestrus smears were recorded as positive and the total positive count was compared with a set of control (sesame oil injected) animals. As our standard of comparison for degree of activity we employed a set of determinations on animals receiving various dosages of crystalline oestrone in sesame oil. The standard oestrone curve is given in Fig. 1. Injections of 0.1 γ and above give a statistically significant increase of positive smears over the control series.

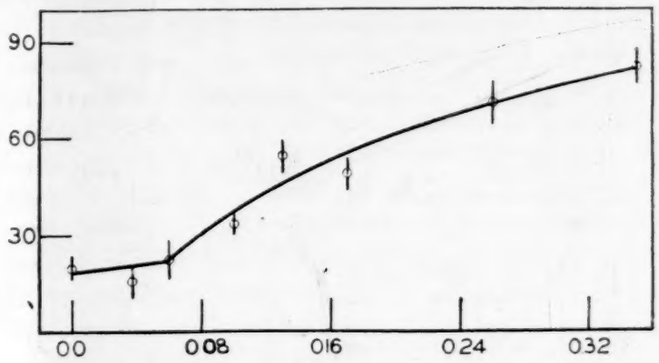

FIG. 1

Abscissa-dosage of oestrone in gamma.

Ordinate—per cent. of positive smears in test mice. The vertical lines at each point are equal to twice the standard error of the measurements.

The synthetic compounds were ordinarily tested in dosages of 100 γ or less, and their activity in terms of oestrone was determined from the standard curve (Table I, column 4). With few exceptions (substances II, III and X) those substances showing no activity in 100 γ dosages were not tested further. On the basis of vaginal cornification alone substances II and III showed an activity of about 10,000 to 15,000 mouse units per gram with low dosages, but no significant increase in activity with higher dosages. Using our standard criteria, however, both compounds were inactive in dosages up to 200 γ. Substance XV, on the other hand, by our method of assay showed an exact proportional increase when the minimum effective dosage was quadrupled.

It will be noted that the addition of auxiliary hydroxy and methoxy groups results in a definite increase in activity. Furthermore, the addition of these groups at either position 6 or 7 results in the same degree of enhancement (compare substances XIII, XIV and XVII) and the presence of these groups at both 6 and 7 (substances XV and XVI) results in approximately three times the activity of the compounds with single additions at these positions. Closure of the fourth ring in the 1,2 position (substance V) is about half as effective in enhancing activity as the hydroxy and methoxy additions. This is the position of the cyclopenteno-ring typical of the native oestrogenic hormones. When the ring is in the 3,4 position (substance VI) we do not obtain a corresponding activity.

That the assay procedure we have employed offers a more sensitive indication of activity than ordinary

[2] *Jour. Am. Chem. Soc.*, 56: 185, 248, 959, etc.

* L. F. Fieser and others, SCIENCE, 83: 2162, 558, 1936.

[1] L. F. Fieser and E. B. Hershberg, *Jour. Am. Chem. Soc.*, 57: 1851, 1935.

[2] L. F. Fieser, M. Fieser and E. B. Hershberg, unpublished work.

[3] L. F. Fieser and E. B. Hershberg, *Jour. Am. Chem. Soc.*, 57: 2192, 1935.

[4] L. F. Fieser and E. B. Hershberg, unpublished work.

[5] R. Deansley and A. S. Parkes, *Jour. Physiol.*, 78: 155, 1933.

TABLE I

No.	Compound Name	m.p., °C. corr.	Activity as per cent. of oestrone activity
I.	1-Keto-1, 2, 3, 4-tetrahydrophenanthrene	94–95	0.56
II.	3, 4-Dihydrophenanthrene-1, 2-dicarboxylic anhydride[1]	263.5–264.5	weak*
III.	Phenanthrene-1, 2-dicarboxylic anhydride[1]	311–312	weak*
IV.	Phenanthrene-3, 4-dicarboxylic anhydride[2]	253.5–254	Inactive in 100 γ doses
V.	1¹, 3¹-Diketo-1, 2-cyclopenteno-phenanthrene[2]	Dec. 240–245	0.22
VI.	1¹, 3¹-Diketo-3, 4-cyclopenteno-phenanthrene[2]	201.4–202	Inactive in 50 γ doses
VII.	2, 3-Dimethyl-1, 4, 9, 10, 11, 12-hexahydrophenanthrene-11, 12-dicarboxylic acid[3]	176–177	Inactive in 100 γ doses
VIII.	Anhydride of VII[3]	95–96	Inactive in 100 γ doses
IX.	Monomethyl ester of VII[3]	157–158	Inactive in 100 γ doses
X.	Dimethyl ester of VII[3]	93.5–94	Inactive in 1000 γ doses
XI.	2, 3-Dimethyl-1, 4, 11, 12, 13, 14-hexahydrochrysene-13, 14-dicarboxylic anhydride[3]	196–196.5	Inactive in 100 γ doses
XII.	9-Methoxyphenanthrene-1, 2-dicarboxylic anhydride	249–250	0.11
XIII.	6-Hydroxy-1, 2, 3, 4, 9, 10, 11, 12-octahydrophenanthrene-11, 12-dicarboxylic anhydride[4]	160–160.5	0.56
XIV.	Methyl ether of XIII[4]	159–159.5	0.48
XV.	6, 7-Dihydroxy-1, 2, 3, 4, 9, 10, 11, 12-octahydrophenanthrene-11, 12-dicarboxylic anhydride[4]	147.5–148.5	1.58
XVI.	Dimethyl ether of XV	146.5–147	1.47†
XVII.	6-Methyl-7-hydroxy-1, 2, 3, 4, 9, 10, 11, 12-octahydrophenanthrene-11, 12-dicarboxylic anhydride[4]	134.5–135.5	0.55

* See text.

† Estimated from data on effects of a single injection.

methods is indicated by our data on substance I. Butenandt[6] obtained positive results when 70 mgms of this substance were injected in a single subcutaneous dose into spayed mice. Cook, Dodds et al.[7] observed marked activity with 100 mgm doses in spayed rats. From the data of these experiments the minimum active dose is about 30 γ. Furthermore, substance XIII, which showed definite activity in 25 γ dosages, gave completely negative results upon subcutaneous injection in 100 γ doses.

And substance XV was inactive in 1 mgm subcutaneous dosages (3 injections in 12 hours), in spayed rats on the basis of vaginal cornification, whereas a 14 mgm dosage in a single subcutaneous injection gave a positive result in rats. It must be emphasized that the method of administration seems to be the all-important factor in determining activity (*cf.* Cook, Dodds *et al.*).

In addition to their oestrogenic effects, certain of these compounds have shown definite activity in the immature rat test, in the augmentation of ovarian growth in rats following FSH stimulation and in the sterilization of rabbits. The details of these experiments will be published elsewhere.

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[6] A. Butenandt and G. Schramm, *Ber.*, 68 B: 2303, 1935.

[7] J. W. Cook, E. C. Dodds, C. L. Hewett and W. Lawson, *Proc. Roy. Soc. Lond.*, B 114: 272, 1934.

PLANT GROWTH EFFECTS OF HETEROAUXIN APPLIED TO SOIL AND PLANTS

β-INDOLYL acetic acid (heteroauxin) in extremely dilute concentrations is known to function as a growth-promoting hormone in plants. The crystalline material was synthesized in this laboratory according to the method of Majima and Hoshino.[1] The indolyl acetic acid used had a melting point of 164–166° C., 8.04 per cent. nitrogen and a neutral equivalent of 176.3; the corresponding theoretical values being 165° C., 7.99 per cent. and 175.1, respectively. An aqueous solution, 1/15,000, was used to determine its effect on growth, rooting, proliferation and bending. Actively growing seedlings were used to detect the effect of heteroauxin during the grand period of growth. One hundred and eighteen day old potted stock seedlings having approximately equal stem lengths were divided into two series. To each pot of the first series 15 cc. of the indole acid solution was added. Each pot of the second series was treated only with an equal volume of water. All the plants were kept under greenhouse conditions and were watered daily throughout the experimental period.

The effect of the indole acid on stem elongation was manifest at the end of the first experimental day, and reached its maximum on the sixth day following its administration (Table I). Curling of the cotyledons on treated plants appeared at the end of the second day, but by the end of the sixth day this effect began to disappear and by the tenth day had disappeared

[1] Majima and Hoshino, *Berichte*, 58: 2042, 1924.

entirely. The differences of stem length between control and treated groups also began to diminish after the sixth day, and by the end of the tenth day no apparent differences between the two groups of seedlings were to be found. The data are statistically significant. It is striking to note the transitory effect of heteroauxin, the action being confined chiefly to the early phase of the grand period of growth with the dosage used directly upon the soil.

TABLE I

COMPARATIVE GROWTH OF STOCK SEEDLINGS (*Matthiola incana*) TREATED WITH β-INDOLYL ACETIC ACID WITH UNTREATED CONTROL SEEDLINGS. STEM LENGTH IN MM.

Day	Control seedlings	Treated seedlings
1	16.0 ± 0.2	16.0 ± 0.5
2	17.0 ± 0.5	21.0 ± 0.5
3	19.0 ± 0.5	26.5 ± 0.0
4	19.5 ± 0.0	30.5 ± 0.4
5	25.5 ± 0.0	38.0 ± 0.0
6	29.0 ± 0.1	40.0 ± 0.5
7	30.0 ± 0.4	41.0 ± 0.2
8	35.0 ± 0.4	43.0 ± 0.3
9	43.0 ± 0.3	45.0 ± 0.3
10	46.0 ± 0.1	48.0 ± 0.1
11	50.0 ± 0.1	51.0 ± 0.0

When localized areas on young healthy plants were repeatedly treated with heteroauxin a definite symptom complex was observable, the speed and intensity of the responses varying with the concentration and amount of the heteroauxin solution used. The sequence of events was, first, a bending away from the treated area due to accelerated growth in the treated region shown in stems, petioles and leaves. Next, swelling due to cell enlargement was observable in and about the treated regions in one to two days. Finally a slight blanching accompanied by proliferation became noticeable, while the stems and petioles continued to increase in thickness. Root primordia appeared a few days later and then gradually developed into anatomically normal roots. At this stage stems had doubled in thickness, become bronzed and sometimes fissured due to excessive growth of medullary tissues. These results confirm those obtained by Hitchcock,[2] using indole-3-n-propionic acid in somewhat greater concentrations on tomato, African marigold, tobacco, dahlia and buckwheat.

The fact that the hormone-like β-indolyl acetic acid occurs in a wide variety of animal tissues (lung, thyroid, thymus, pancreas and gonads) as well as plant tissues (fungi, bacteria and angiosperms) suggests that it may have a common function especially in relation to cellular metabolism. It seems especially important to meristematic and mitotic activity related to differentiation.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

RECONDITIONING APHIDS FOR STUDY

IN 1903 W. T. Clarke, of the University of California, published an article in the *Canadian Entomologist*[1] in which he described a number of new and well-known species of aphids. His work was of the pioneering, fundamental type and was quite typical of the times. Some of his specimens were mounted in balsam on microscopic slides, and these were subsequently lost or destroyed, so that no authentic types remained. This loss has resulted in much confusion in the study of the California Aphididae in recent years. Attempts have been made to restore certain of the species named by Clarke, but these efforts have been based largely upon conjecture and circumstantial evidences only. I have had occasion to discuss the probable identity of his types with Clarke, whom I knew well for the last ten years of his life, but his long divorcement from the study of insects had erased any distinct recollections which might serve to reestablish his species. In 1930 I discovered in the attic storeroom of Agriculture Hall a small box containing some thirty small homeopathic vials of aphids bearing labels in the handwriting of Clarke. This find was extremely interesting and important to me, but careful examination revealed a sad state of affairs. Although the corks appeared to be tight, the liquid preservative had disappeared completely from all except two or three vials containing only the common, well-known woolly apple aphis, *Eriosoma lanigerum* (Hausmann). The specimens in the dry containers appeared as mere dust composed of finely shattered bits of legs, antennae, wings and other body fragments. In spite of the fact that one of these vials contained *Aphis mori*, marked "types," and some other material which might prove to be cotypes of Clarke's lost species, I was convinced that no real information could be salvaged from the find. Nevertheless, the collection was preserved *in toto*. More recently in clearing aphids in KOH for microscopical study it was found that dried specimens were not only restored to much of the original form, but were also rendered clear and partly transparent. Accordingly, all the vials containing the Clarke specimens were filled with a 10 per cent. solution of KOH and set aside for seven days. To my satisfaction I discovered that what appeared to be a mass of fragments was composed of aphids, many of which were in

[1] *Can. Ent.*, 35: 247–254, 1903.

[2] Hitchcock, Contributions Boyce Thompson Inst., 7: 87, 1935.

a fair state of completeness. When thoroughly washed in distilled water, treated with acetic acid to remove all traces of the potash, dehydrated in alcohol and mounted in euparal or balsam on microscopic slides, the specimens proved to be quite adequate for the determination of the species. In the case of certain specimens the antennae, in particular, were often fragmentary, but a series of individuals revealed all the important characters necessary in classification. Thus it is possible to reestablish beyond doubt and to preserve permanently a considerable number of Clarke's species. The material thus reconditioned is sufficient to form the basis for a fairly complete report on the Clarke collection, which is in preparation and will be published later.

It has occurred to me that this experiment might prove valuable to curators of entomological collections who may now be in possession of fragile insect types which are in danger of destruction. Thus remnants of aphids mounted on points may be safely transferred to permanent slide mounts, where they are available for convenient study without danger of mutilation.

Permanent slide mounts of years' standing may also be reconditioned by first removing the balsam by submerging the slides in xylene or in Carlson's solution[2] consisting of ninety parts of xylene and ten parts of n-butyl alcohol. The opaque specimens may then be cleared in KOH as aforementioned, washed, dehydrated and remounted. With reasonable amount of care the individual insects may be restored to new slides in perfect condition if the work is done under a binocular microscope. Very transparent specimens are rendered more distinct by staining with magenta red or fuchsin, previous to or following dehydration. Especially are the wax-producing species improved for study because of the wax glands and pores, which may prove valuable characters in classification, as they are rendered more easily discernible under the microscope. The writer is subjecting lots of all species collected to the above described treatment and is finding that all forms, light and dark, are greatly improved thereby.

E. O. Essig

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AN ELECTRICAL REMEDY FOR TREE BORERS

The writer recently rigged up a magneto as an amusement device for a pair of growing youngsters, with which they could give mild shocks to themselves and other youngsters of the neighborhood. Later, having heard of the method of driving earthworms out of the ground by electric current, the magneto was turned to this use. When a pair of steel rods wired to the magneto were thrust into wet ground about six inches apart and the crank turned, the earthworms came crawling out. Still later, when the writer was engaged in the laborious task of digging elm-borers out of a tree with a pocket knife, the idea came of turning the magneto to use for this job. When two nails were driven into the bark a few inches apart in the affected area, the nails attached to the magneto and the crank turned, the elm-borers came out in a few seconds. Subsequent digging in the electrically treated bark proved that the borers had vacated 100 per cent.

The system is much less laborious than digging out the borers and far more amusing. A magneto somewhat more powerful than the writer's would no doubt be quite valuable to orchardists and commercial tree surgeons.

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AN IMPROVED METHOD OF PREPARING DISTRIBUTION MAPS

The distribution of species is commonly represented by means of black dots on outline maps. Such maps can be very easily prepared by punching the dots out of black gummed paper (such as lantern-slide binding-tape) with an ordinary ticket punch and sticking them on the map. This method is quicker, produces more uniform results and photographs better than when the dots are drawn in with ink. By using various sizes and shapes of punches different dots may be made for different varieties and species. Open circles can be produced by gluing a small white circle in the center of a larger black one.

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[2] J. Gordon Carlson, Science, n. s., 81: 365, 1935.